**Model Examination - October 2013**
**Seventh Semester  - Chemical Engineering**

**CH 2407 – Process Equipment Design II**

**Time: Three hours**                                           **Maximum: 100 marks**

**Answer ALL Questions**

**Part A  (5 x 2 = 10 marks)**

1.  What is meant by correction factor for LMTD?
2.  'Higher pressure fluid is to be placed on the tube side of the shell-and-tube heat exchanger'. Justify this statement.
3.  What is the effect of dissolved solid contents on the boiling point of the solution?
4.  Why is low pressure steam preferred over high pressure steam in evaporation?
5.  Draw the schematic of 2-2 shell and tube heat exchanger.

**Part B (20 marks)**

6.  Write down the steps involved in designing the following equipment.    (5)

7.  Make suitable calculations to show that the given design is satisfactory. (15)

**Part C  (50 marks)**

8.  Draw to scale the suitable views of the equipment, mark the salient parts, and

    dimensions.

**Bubble-cap Distillation Column**
Acetone ($CH_3COCH_3$) is to be recovered from an aqueous waste steam by continuous distillation. The feed contains 3.3 mole % of acetone. Acetone of at least 94 mole % in the product is required, and the aqueous effluent must not contain more than 0.016 mole % of acetone. The ideal number of stages based on 100% tray efficiency is estimated to be 16. The average tray efficiency is assumed to be 80%. Reflux ratio is maintained at 1.35. Saturated liquid feed is used.

*Properties of fluid at the operating temperature are:*
Density of acetone vapor = 2.05 kg/m$^3$; Density of liquid acetone = 753 kg/m$^3$.
Density of water vapor = 0.72 kg/m$^3$; Density of liquid water = 954 kg/m$^3$.
Molecular weight of acetone is 58; and that of water is 18.
Surface tension of acetone-water feed liquid against its vapor at the feed composition is 25 dyne/cm.

*A distillation column of the following configuration is available:*
Distillation Column is 3 feet in inner diameter, 10 mm thickness shell, 20 bubble cap trays with a tray spacing of 0.6 m. Feed is introduced in 10$^{th}$ tray from top. The column is supported on the ground with a skirt support. Man-holes of
$\phi$500 mm are available in between (a) 5$^{th}$ and 6$^{th}$ tray from top, and (b) 15$^{th}$ and 16$^{th}$ tray from top. And a sight glass of $\phi$300 mm is available over the feed tray. Other dimensions of tray are given below:

**Details of cap**
Nominal diameter = 4inch
Number of caps = 27
Pitch = 5.25inch, triangular

**Details of tray**
Cross flow tray with weir on the inlet and outlet down-comers
Weir length = 24.75inch; weir height = 3.5inch
Max distance between down-comer plate and column
     at the outlet of down-comer = 2.5inch
No of weep hole of 3/8 inch dia = 4
Cross sectional area of down-comer is about 15% of the total column cross sectional area.

**Man-way details:**
Hexagonal man-way plate attached with the tray by bolting arrangement
Width of man-way plate = 13.75 inch
Maximum length of man-way plate = 26inch

**(a) Check whether the above design is satisfactory** for a feed flow rate of
300 kmol/h, and the operating velocity of vapor at 65% of the flooding velocity.

**(b) And draw:**
     (i) Line diagram of distillation column assembly indicating the feed tray,
     sight-glass,    man-holes location.
     (ii) Details of a typical tray (plan and elevation)